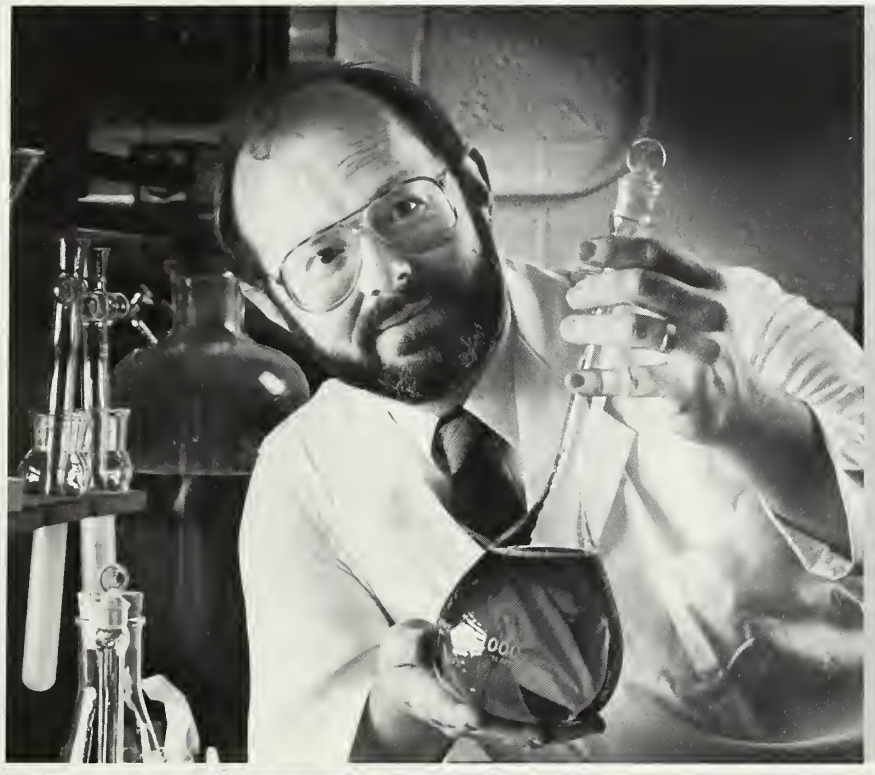
ment of Agriculture Agricultural Research Service Vol. 35, No. 10, November/December 1987

Agricultural Research

Distinguished Scientists of the Year



"Soybean oil's tendency to turn rancid costs the industry about $700 million a year in extra processing. Our custom-designed soybean plants can turn this around."

Richard F. Wilson

"The U.S. turkey industry needed a way to make artificial insemination more efficient. It was gratifying to be able to help them out."

Thomas J. Sexton

Today's Plans for Tomorrow's Plants

On November 18th, USDA's Agricultural Research Service and the University of California dedicate the nation's first joint government-university laboratory devoted entirely to plant gene research at the molecular level.

Located in a newly remodeled wing of ARS' Western Regional Research Center in Albany, California, the new Center is expected to employ some 50 scientists and support staff.

Gerald G. Still, long-time proponent of a special center for plant gene research, and now its first director, talks here about what the research is likely to achieve.—Ed.

Ag. Res. What's the purpose of the Plant Gene Expression Center?

Still. Our mission is in our name. We want to find out how a plant carries out the instructions contained within its genes—how are they "expressed" throughout the plant's life? How are genes, such as those that instruct the plant to form a flower and then produce a fruit, turned on or turned off at the right times? How can we control these genes? By understanding these very basic mechanisms, we can engineer new ways to improve plants. We're interested not only in food plants, but in those used for other things such as fiber or industrial chemicals.

Ag. Res. When you talk about the Center with people who aren't scientists, do you have an analogy that you find helps them understand your research?

Still. Well, I sometimes suggest that one way to think about all of this is to regard a plant's "informational" molecules—those that give the plant its instructions and cues—as organized into a library. The bookshelves in this library are the chromosomes. Each volume on the bookshelf is made up of chapters, paragraphs, sentences, and words. Our task is to provide the technology for altering specific paragraphs or sentences located in specific chapters or volumes, so that the informational cues the plant follows will give us the product we want.

Ag. Res. Crop plants can easily contain 200,000 or more genes. Do the numbers present a problem?

Still. Yes, this is not simple or straightforward research. We need to determine which genes control what and where they are located on the chromosomes.

For example, drought resistance in a plant may be controlled by not just one gene, but by many. And multigene functions may have genes working at different times. That's why there's a lot of very basic work to be done before we can intervene with things like a plant's photosynthetic efficiency, its flowering patterns, or its rate of aging.

Ag. Res. Besides these, what other genetically controlled processes will your team be studying?

Still. We're staying close to what might be called the recalcitrant questions of agricultural biotechnology—the tough questions that will probably take years to resolve.

For instance, one question we'll try to answer is how to successfully transfer foreign genetic material into the very important class of plants known as monocots, such as corn or wheat. We'd like to be able to at least equal the ease with which genes can now be introduced into tomatoes or tobacco in the dicot class.

Unexpected variations raise another question. When you take cells from a parent plant and try to grow them into new plants under laboratory conditions, perhaps 1 out of 1,000 will be different from what you started with. This somaclonal variation can wreak havoc with genetic engineering experiments.

We know that a molecule called phytochrome detects the light plants need for growth, but we need to know in finer detail what's going on during this process, so that we can take advantage of it.

When plants are attacked by diseases, we really don't know much about how individual molecules and cells within the plant respond to the attack. We need to know this so we can more precisely and rapidly engineer plants that have superior resistance to disease.

We know that cells in plants divide according to genetically controlled cues, but we don't know which genes determine whether the new cell will be a root cell, fruit cell, or the like.

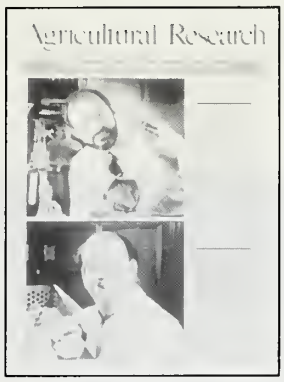
Ag. Res. What sort of practical benefits will the research offer?

Still. Our research should give the grower more control over the quality and quantity of a crop and the profits it brings. For example, we might be able to manage the timing of fruit development to avoid seasonal pests.

Ag. Res. Would you describe your goals for the center as optimistic or as realistic?

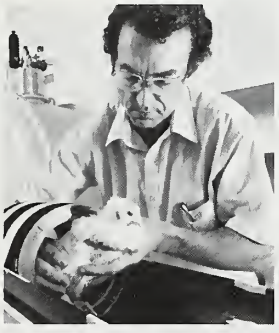
Still. I'm optimistic that we can achieve them or at least come very close. And I think I'm being realistic about the time it will take. It may be 15 or 20 years before we've fully answered the questions I've mentioned. After all, we're working here with some of the most complex and intricate structures and mechanisms known to science. We will work with cooperators in our research consortium—a group of private and public research institutions that will join us in moving our discoveries from the laboratory to the field.

Interview by **Marcia Wood,** ARS.



Agricultural Research

Cover: The Agricultural Research Service's top award for scientific achievement went to Richard F. Wilson and Thomas J. Sexton. More about their research as well as that of this year's outstanding scientists on page 6. Photos by Robert Flynn (top, 0987X1009-6) and Tim McCabe (bottom, 0987X984-33).



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Richard E. Lyng, Secretary
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Orville G. Bentley, Assistant Secretary
Science and Education

Terry B. Kinney, Jr., Administrator
Agricultural Research Service

New Antibiotic Helps Protect Plants

A new antibiotic that may protect against "take-all," a major disease of wheat worldwide, has been discovered by U.S. Department of Agriculture scientists.

"A special strain of the bacterium, *Pseudomonas fluorescens,* is the only known producer of the antibiotic," says plant pathologist David M. Weller of USDA's Agricultural Research Service.

Weller says laboratory tests at Pullman, Washington, show that the new antibiotic, given the name P 2-79, inhibits about 40 other kinds of soil micro-organisms, including those that damage oats, barley, rye, and turf grass.

He found that P 2-79, when applied to wheat seeds in laboratory studies, protected the roots from the fungus that causes the disease. It is called take-all because the fungus can kill an entire crop.

"We never expected this antibiotic to work so well," he says. "We started out studying how *Pseudomonas* protects wheat against take-all. What we came up with was a new antibiotic and a way to easily and cheaply produce large quantities of it in the laboratory."

If the antibiotic performs well in field tests, he says, it could become the latest defense against take-all. This disease damages more than 600,000 acres of wheat in the highly productive Pacific Northwest region of eastern Washington, Oregon, and Idaho, where about 25 percent of U.S. wheat—worth $350 million—is grown for export.

Weller, colleague R. James Cook, and Washington State University microbiologist Sarangamat Gurusiddaiah cooperated in discovering the effects of the new antibiotic on the take-all fungus.

"Wheat can best be protected when *Pseudomonas* bacteria are applied to the seed before it is sown," Cook says. "The bacteria then produce the antibiotic on the developing roots."

USDA has applied for a patent for the antibiotic. Companies interested in manufacturing it or in using the extraction process can apply to the ARS patent coordinator for a license. [See page 16.]—By **Howard Sherman,** ARS.

David M. Weller and R. James Cook are in USDA-ARS Root Diseases and Biological Control Research, Johnson Hall, Room 367, Washington State University, Pullman, WA 99164. ♦

USDA Helps Save Cranes

"Moldy grain may have caused the mysterious illness that threatened to wipe out a U.S. Department of the Interior breeding flock of endangered cranes this past fall," says John L. Richard, a microbiologist at the ARS National Animal Disease Center in Ames, Iowa.

"The symptoms—kidney damage and dehydration—made us think an unusual fungal toxin was involved," says Richard, who was called by the U.S. Fish and Wildlife Service's Patuxent Wildlife Research Center in Maryland to determine the cause. "But the tests we've made so far have not demonstrated the toxin that we first suspected, nor did we find aflatoxin, a more common poison, or any other molds that produce aflatoxin," says Richard. "We'll test more feed samples at our lab and at various others."

The crisis at Patuxent began on September 19 when many cranes became sick suddenly. All told, about 80 percent of the center's cranes became ill, though only about a third at any one time. The final death toll: three adult whooping cranes, including one of the best breeders; one Mississippi sandhill crane, a species even more endangered than the whooper; and 11 Florida and greater sandhill cranes.

The last death occurred on October 9. The deaths were stopped by a change in feed and a regimen of medicines and tube feeding of sick

Immature whooping crane. The protected flock at the Patuxent Wildlife Research Center in Maryland near Washington, D.C. includes nine young cranes. (PN-7260)

birds instituted by specialists at the Wildlife Center.

Fortunately, Patuxent has a frozen sperm bank that serves as an insurance against the possibility of losing the genetic lines represented by male whoopers and Mississippi sandhill cranes. "If we just had one or two females left, we could thaw the semen, inseminate, and recover the lines," says George F. Gee, an avian physiologist in the Endangered Species Research Branch at Patuxent.

ARS scientist Thomas J. Sexton helped Gee set up this sperm bank, using the experience Sexton had with freezing chicken semen. Gee and Sexton also found that a semen diluent developed by Sexton works well with cranes too, with only minor modification. This diluent keeps

sperm alive from the time it is collected until it is used to inseminate the female.

Gee has used modifications of the diluent for sperm of the yellow seaside sparrow, the house sparrow, the American kestrel, the endangered Andean condor and the endangered Aleutian Canada goose.

The Patuxent Wildlife Research Center presently has 293 cranes, mostly of the nonendangered sandhill species. The sandhills serve as foster parents for newly hatched whooping and Mississippi sandhill cranes being raised at the Center.

In addition to the whooping cranes living in captivity, two flocks of whooping cranes exist in the wild. The main group, numbering about 145 birds, migrates between Canada and Texas each year. A second flock, established by wildlife researchers, travels between Idaho and New Mexico. Of the 30 birds in the smaller flock, 10 hatched from artificially inseminated eggs.—By **Don Comis,** ARS.

John L. Richard is at the USDA-ARS National Animal Disease Center, Ames, IA 50010. Thomas J. Sexton is at the USDA- ARS Avian Physiology Laboratory, Beltsville, Md. 20705. George F. Gee is at the Patuxent Wildlife Research Center, Laurel, MD 20708. ♦

Male Insect's Sex Lure To Trap Females

Many a male insect, believing he is sniffing out a mate, has been enticed to his death by an artificial copy of the sex scents of female insects.

Now the gender tables are turning. The sex scent, or pheromone, of the male papaya fruit fly has been duplicated by Agricultural Research Service scientists.

"This is a sort of role reversal with pheromones, because in most insect species the female attracts the male," says entomologist Peter J. Landolt in ARS' Gainesville, Florida, lab.

Working with colleagues Robert R. Heath, Tatsuji Chuman, and James H. Tumlinson, Landolt found, identified, and synthesized the chemical emitted by male papaya fruit flies while they sit on papayas and wait to mate.

TIM McCABE

Male papaya fruit fly, whose sex scent has been synthesized in ARS labs, costs papaya growers about $2,000 per acre in damaged fruit and control costs each year. (1286X1372-3)

Papaya fruit flies, often mistaken for wasps, cost growers in Florida up to $2,000 an acre each year in pesticide treatments. Farms in Central and South America are also plagued by infestations. Landolt notes that growers can apply pesticides and still lose up to 50 percent of their crop.

Hungry fly larvae begin inflicting damage as soon as they hatch, since they are deposited inside the fruit as eggs.

The new lure looks promising. In wind-tunnel and field tests, it prompts females to fly toward it in the same zigzag pattern they use when following the scent in nature.

Testing has drawn to a close on the trap itself, which is simply an imitation papaya covered with a sticky substance to catch and hold female flies.

"We think that the visual aspect of the papaya, in addition to the pheromone, makes the flies actually land," Landolt says. "Lab tests indicate that we have determined the correct shape and colors needed to make an effective trap. Hung in a farmer's papaya grove, the trap would be both environmentally safe and relatively cheap."

USDA intends to apply for a patent on the synthesized pheromone.

Only one other male pheromone has been copied in the lab so far as an insect control—a "gathering" scent put out by the male boll weevil. But this pheromone, commercially sold, traps males along with the females, according to Landolt.

Scientists at Gainesville are performing similar studies on sex pheromones of male Caribbean and Mediterranean fruit flies.—By **Jessica Morrison,** ARS.

Peter J. Landolt is in the USDA-ARS Insect Attractants, Behavior, and Basic Biology Research Laboratory, P.O. Box 14565, Gainesville, FL 32604. ♦

Wanted: An Ugly Christmas Tree

The Austrian pine is very tolerant of road salt, but it's too pretty for its own good. What state highway officials need is a salt-tolerant tree that's too homely to be a Christmas tree. Pines are the preferred trees for year-round landscaping beside roads. But two of their enemies are road salt—which kills their cells—and people who cut down symmetrical ones like the Austrian for Christmas trees.

An Agricultural Research Service study of salt tolerance in pine trees inadvertently turned up a less Christmasy alternative to Austrian pine—Japanese black pine. It ranked in the top three in resistance to salt, alongside Austrian pine, but lacks its pretty shape.

In the 3-year study, Alden M. Townsend, a geneticist at the ARS National Arboretum in Washington, D.C., subjected 13 pine species to a salt spray similar to that kicked up by cars and trucks passing over slushy salted roads.—By **Don Comis,** ARS.

Alden M. Townsend is at the USDA-ARS U.S. National Arboretum, 3501 New York Ave., NE., Washington, DC 20002. ♦

Four Top Researchers in the Limelight

Agricultural Research Service Administrator Terry B. Kinney announced joint winners for the 1987 Distinguished Scientist of the Year. It was the first time in the prestigious competition's 6-year history that two scientists were named for the annual top honor.

Sharing this year's highest scientific award are Richard F. Wilson, a plant physiologist at Raleigh, North Carolina, and Thomas J. Sexton, an avian physiologist at Beltsville, Maryland.

ARS also honored two Outstanding Scientists of the Year: Marvin J. Grubman of the Plum Island Animal Disease Center, Greenport, New York, and Edward B. Bagley of Peoria, Illinois.

Richard F. Wilson
Distinguished Scientist of the Year

Richard F. Wilson has focused years of research on the soybean. His biochemical studies may result in a far longer shelf life for soybean oil—a critical element in the world's food supply.

"Soybean oil's tendency to turn rancid costs the industry about $700 million a year in extra processing," he says. "Our custom-designed soybean plants can turn this around."

Commercial soybean oil processors had found that one of the oil's components, linolenic acid, causes the oil to go bad. But commercial methods of processing the oil to lower its linolenic acid content are costly.

Wilson began a search for soybeans containing less linolenic acid, a quest that caused him to study how the beans manufacture this unwanted component. He and his collaborators succeeded in describing the genes and the biochemical process that control its synthesis.

Results of his effort? Three new lines of soybeans were developed, each having about 3.5 percent linolenic acid, a percentage formerly achieved only through commercial hydrogenation.

Wilson also developed a soybean strain with low palmitic acid—a highly saturated fatty acid suspected of contributing to blood serum cholesterol. Manufacturers of plastics also desire soybean oil with less palmitic acid; they consider it a waste product.

In addition to these discoveries, the springboard effect of Wilson's leadership has won praise. Team members have made across-the-board improvements in soybean research, yielding knowledge of the enzyme systems within the nitrogen-fixing micro-organisms; development of germplasm for high-yielding, high-protein plants; and identification of soybeans that are most tolerant of drought.

"We make it our business to know the problems farmers who grow soybeans are facing," says Wilson. "We want to give them a soybean with more marketable characteristics."

Pointing with pride to his co-workers' productivity, Wilson notes, "This team effort has been as close-working as any I've seen. We're all doing our part to increase utilization of soybean oils and protein."

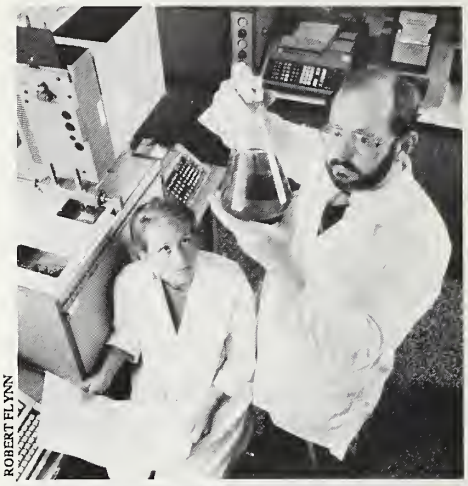
Thomas J. Sexton
Distinguished Scientist of the Year

It's doubtful that many of the millions of Americans who carve turkeys on Thanksgiving Day will salute the name Thomas J. Sexton with a tip of the holiday drumstick. Yet he is among a scant number of poultry scientists who have brought about improvements in selective turkey breeding that were considered revolutionary by the turkey industry. Because of Sexton's work, large-scale selective turkey breeding has become a commercial success story.

Tom Sexton's field of expertise, preservation of avian semen, is not a glamorous one, even among animal scientists. Still, his diligent work has changed the course of the poultry business. Consider the wild turkey, famed for its elaborate ritual of courtship. He's quite the romantic when compared to his domestic cousins. Some domestic turkeys have been bred for so much white meat that the toms' breasts prevent normal mating.

Turkey farmers were elated when Sexton developed the Beltsville Poultry Semen Extender, a diluting agent that helps keep sperm alive for 24 hours without freezing—a time interval far longer than was possible previously. This meant the turkey industry could centralize semen production at turkey stud farms and transport it to turkey producers as it was needed; hens no longer needed to reside nearthe toms.

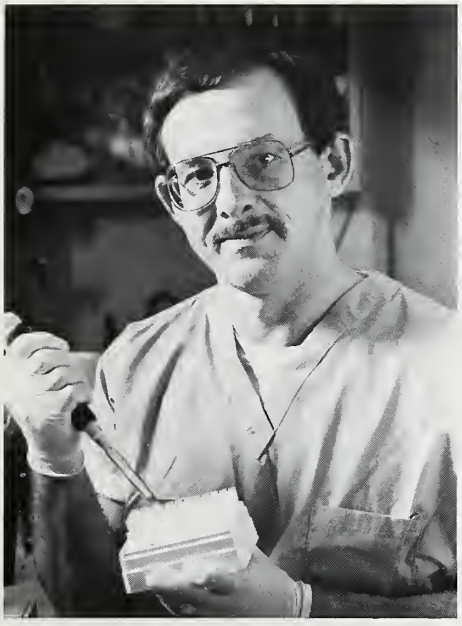
The extender concept was first considered when Sexton tried to sell the turkey industry on the idea of freezing semen. "Industry leaders told us that our ideas were interesting. But they felt a


ROBERT FLYNN


TIM MCCABE

Top: Plant physiologist Richard Wilson and technician Laura Cox analyze the chemical composition of soybean extracts for constituents related to oil flavor. (PN-7259)

Above: Poultry physiologist Thomas Sexton candles eggs from artificially inseminated turkey hens to confirm successful fertilization. (0987X985-6)



TIM McCABE

BOB BJORK

Top: Marvin Grubman, a chemist at the Plum Island Animal Disease Center, New York, works on identifying proteins that make up the outer coat of the foot-and-mouth disease virus. (1087X1085-8A)

Above: New plastics made from cornstarch and petroleum-based polymers were developed at the ARS Northern Regional Research Center by chemists Edward Bagley (right), Richard Westhoff (left), and Charles Swanson. (Not pictured are chemists George Fanta and Felix Otey, retired, who also worked on the new plastics.) (0987X967-27)

short-term (24-hour) semen extender, rather than the frozen process we were developing, would be a better solution to their breeding problems," he recalls.

"After listening to poultry farmers describe what they wanted, I realized that we had the right strategy— artificial insemination—but we needed to make the process more practical. Artificial insemination had potential to make the U.S. turkey industry more efficient. It was gratifying to be able to help them out."

Under Sexton's leadership, ARS scientists have found ways to lower the cost of feeding male breeding turkeys. They have also developed an automated system for injecting turkey eggs with a vitamin that increases hatchability.

Marvin J. Grubman
Outstanding Scientist of the Year

Foot-and-mouth disease is among the world's most feared contagious disorders of cattle and swine. It's extremely infectious, it's economically devastating, and it has no cure. To Marvin Grubman, however, the virus represents a fascinating puzzle.

The research chemist was cited by ARS for his contributions to the study of molecular properties of animal viruses. This work includes unravelling and describing the foot-and-mouth virus, as well as developing of the first genetically engineered vaccine against the disease.

Working at the Plum Island Animal Disease Center, a few miles off Long Island, New York, Grubman began his attack on the elusive virus by examining its protein content. He and coworkers identified the gene responsible for production of one of the major proteins in the virus. When this gene was inserted into bacteria, the bacteria in turn produced large quantities of the protein in culture.

The bacterially produced protein has proven to act as a vaccine; inoculated animals have shown an immunity to a laboratory strain of foot-and-mouth disease. The virus contains other elemental proteins, and work continues on incorporating them into an improved vaccine.

"In the future," he says, "we'll learn more about the virus structure and its unique mechanism of replication and therefore may produce improved vaccines. At the same time, we'll be looking for alternative means of inhibiting virus growth."

Edward B. Bagley
Outstanding Scientist of the Year

The term "multidisciplinary approach" normally describes teamwork among men and women who represent different branches of science. But Edward Bagley is a rare example of a scientific jack-of-all-trades. He's a one-man multidisciplinarian whose work spans physics, engineering of polymers, solution thermodynamics, agricultural engineering, and carbohydrate chemistry. Bagley is among the developers of super slurper, a cornstarch derivative that absorbs 1,400 times its weight in moisture. Super slurper is a commercial superstar: Today it can be found in dozens of commercial products ranging from disposable diapers to fuel filters.

Not content to rest on past accomplishments, Bagley went on to lead an award-winning research team studying aflatoxin, a cancer-causing substance produced by fungi. They succeeded in finding a way for farmers to decontaminate corn of aflatoxin.

Of late, a specialized part of physics occupies Bagley's interest—rheology. It's the study of deformation and flow of materials. In this work, concepts from disciplines as far removed as polymer science and metallurgy can be combined and applied to processing and characterization of foods.

If these studies seem a bit esoteric and remote, Bagley doesn't agree. He says, "Of all the applications of science, agriculture seems to me the most inclusive. There are so many variables to consider, so many systems where an integrated approach is critical. One aspect of agricultural research can never exist in isolation from all.—By **Regina Wiggen**, ARS.

Richard F. Wilson is at the USDA-ARS Soybean and Nitrogen Fixation Research Unit, P.O. Box 7620, Raleigh, NC 27695-7620. Thomas J. Sexton is at the USDA-ARS Avian Physiology Laboratory, Bldg. 262, BARC-East, Beltsville, MD 20705. Marvin Grubman is at the USDA-ARS Plum Island Animal Disease Center, P.O. Box 848, Greenport, LI, NY 11944. Edward B. Bagley is at the USDA-ARS Northern Regional Research Center, 1815 North University St., Peoria, IL 61604. ♦

Magnetic Resonance:

A View From Within

Until recently, high-energy X-rays have been the "eyes" of science, providing researchers with their only window into a living body.

Now bioscientists have opened a new window into their plant or animal subjects—magnetic resonance (MR). This tool, already being used in high-tech medical research, lets scientists see a cross section of a plant or animal without having to cut into it or even subject it to X-rays.

That's because the new diagnostic system works by creating images from low-energy radio waves. Its uses in agricultural research abound, from checking apples for internal diseases to monitoring the uptake of minerals by plant roots. As the photo on page 10 shows, it can harmlessly slice through a pig to show the growth of fat layers under the skin.

The information magnetic resonance unearths from a sample can be viewed in one of two forms—as a TV-like image (MRI) or as the jagged lines on paper of a spectrographic analysis (MRS).

But whether the output is a video image or a series of data points, the diagnostic principle is the same. When a specimen is put into the strong magnetic field, atoms within it that are naturally magnetized nuclei—hydrogen, for example—tend to orient themselves in the field the way a compass needle lines up with the poles in the Earth's magnetic field.

The trick to MR is to give each of the nuclei a little push with a short pulse of radio waves while they are lined up. When the pulse ends, the nuclei bounce back or resonate into alignment again and give off a faint radio signal of their own. It's those signals that are picked up by the MR device and transmitted to a computer for analysis and conversion into a visual image or spectrum.

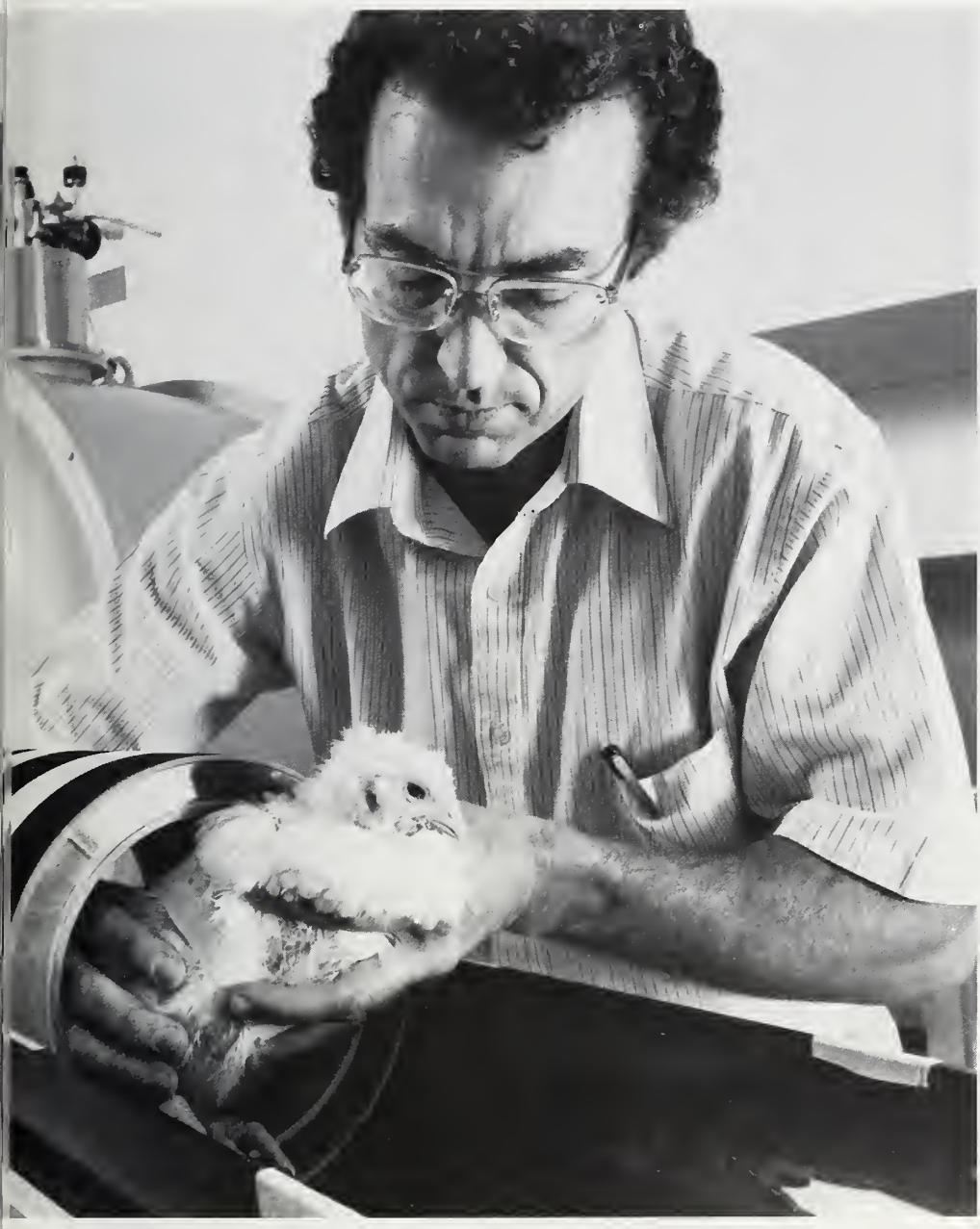
Magnetic resonance instruments consist of a donut-shaped superconducting electromagnet, a radio-frequency generator, and a high-speed computer for evaluating the resonance from a specimen. The magnet, which is cooled by liquid helium, can produce 30,000 to 60,000 times the strength of the Earth's natural magnetic field.

BOB BJORK

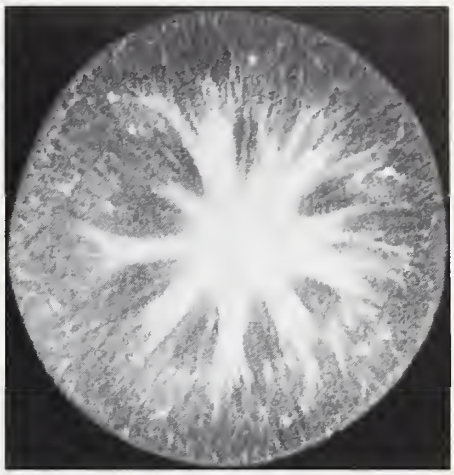
At the ARS Northern Regional Research Center, Peoria, Illinois, chemist David Weisleder uses magnetic resonance to identify pesticides occurring in plant material. On the screen, Weisleder observes spectrum obtained from a molecule of naturally occurring pesticide. Raw MR analysis translated into graph form will be interpreted to define structure of the molecule. Pesticide experts will then determine if the molecule is unique or previously known and if the molecule is potentially useful and effective. (0987X966-5)

TIM McCABE

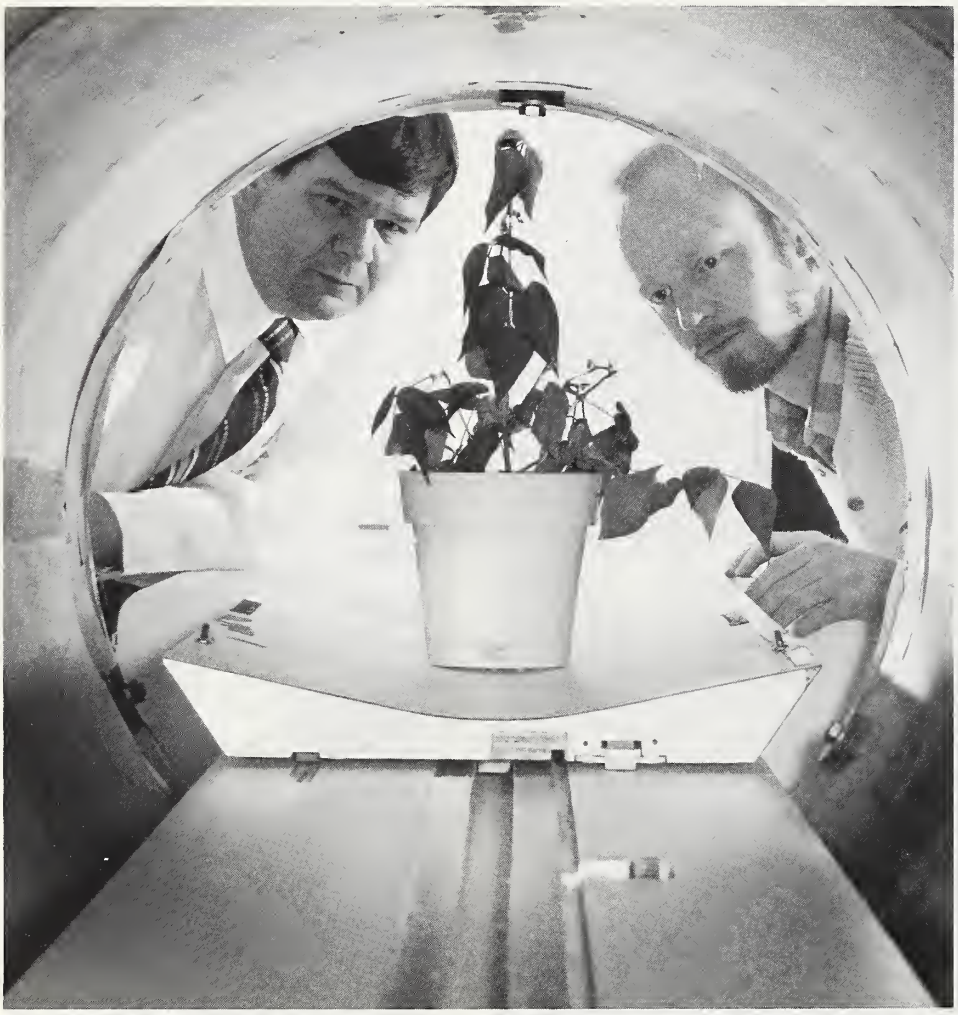
This kind of hardware is expensive. In October, USDA's Agricultural Research Service purchased five research-sized units (8-inch-diameter specimen tube) for about $500,000 apiece—roughly a quarter of the cost of larger whole-body medical-imaging equipment. These new machines will be located at ARS laboratories in Fargo, North Dakota; Philadelphia, Pennsylvania; Peoria, Illinois; Athens, Georgia; and Beltsville, Maryland. The agency has a number of older units in use and also has access to several larger ones through cooperative arrangements with medical and industrial researchers. ♦



To study muscle development in response to diet in chickens, ARS animal scientist Alva Mitchell (right) and Paul Wang of Georgetown University Hospital prepare a chicken for magnetic resonance imaging at the hospital's laboratory. The large cylinder which looms in the background contains a powerful magnet that can turn such metallic objects as belt buckles, watches, and jewelry into missiles. It also erases magnetic encoding on credit cards and the like as researcher Wang discovered when he forgot his laboratory "key card" in his pocket. (0987X1047-33)



Above photos taken with magnetic resonance imaging compare normal apple with one with water core. Star-shaped white area in top photo indicates extent of this disorder. Although water core does not affect eating quality of newly harvested apples, it often causes decay in cold storage. Scientists can study an individual apple over its storage life because MRI does not damage the sample. (PN-7258 top, PN-7257 bottom)

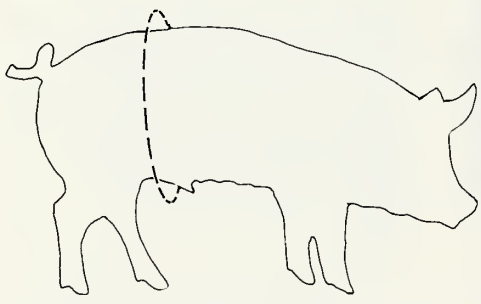


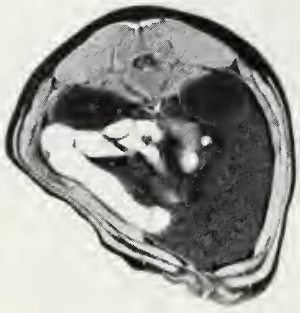
(GENERAL ELECTRIC RESEARCH AND DEVELOPMENT CENTER)

TIM McCABE

Above, left: Hugo Rogers (left), an ARS plant physiologist at the ARS National Soil Dynamics Laboratory, Auburn, Alabama, and Paul Bottomley, a physicist with General Electric Corp., study the structure and functioning of the roots of living plants. ©General Electric Research and Development Center, Schenectady, New York

Above: At the ARS Eastern Regional Research Centerin Philadelphia, chemists Walter Gerasimowicz (top) and Philip Pfeffer prepare a nuclear magnetic resonance instrument to study how different minerals are absorbed by corn root tissue. (0586X624-36)





Drawing of pig, left, shows where cross section was made by magnetic resonance imaging. Spine, loin muscles, and kidneys are visible in upper part of MR image (right). Scientists can measure fat development under the skin quickly without injury to the pig. Flattening of image at lower left is from padded support surface inside the device. (PN-7256)

USDA Fat-Measuring Meter To Be Made Commercially

A light meter that measures body fat will be produced by a Gaithersburg, Maryland, company that based its design on technology developed by USDA's Agricultural Research Service.

Karl H. Norris, agricultural engineer, and Joan M. Conway, chemist, at the ARS laboratories in Beltsville, Maryland, discovered that an individual's percentage of body fat can be determined by using reflected infrared light analyses from five places on the body, including the biceps.

Norris invented the reflected infrared light technology originally for testing agricultural commodities.

Using the researchers' discoveries, Futrex, Inc., a commercial instrumentation company, designed a handheld meter that gives a digital readout in less than 10 seconds. A computer built into the meter compares a person's weight, height, age, and sex with medically established values and produces a customized printout suggesting an individualized health and fitness plan.

—By **Dvora Aksler Konstant.**

Karl H. Norris is in the USDA-ARS Instrumentation Laboratory and Joan M. Conway is inthe USDA-ARS Energy and Protein Nutrition Laboratory. Both laboratories are at the Beltsville Agricultural Research Center, Beltsville, MD 20705. ♦

TIM McCABE

Right: Karl Norris (right), ARS agricultural engineer, and Robert Rosenthal, president of Futrex Inc., demonstrate Futrex's new body-fat analyzer based on near infrared light technology developed by Norris. (0987X993-4)

TIM McCABE

Left: Using ARS developed technology, computerized instruments provide a quick measurement of total body fat percentage at a touch of a light wand to a person's bicep. If age, weight, body type, sex, and activity level are typed into the larger model, it can provide a customized weight loss and activity program to improve that person's muscle-to-fat ratio. (0987X994-35)

Corrections

In the October 1987 issue, ARS scientist Van Wann is fourth from right in photo appearing on page 6. Three Rivers Produce Plant manager Jerry Sears is third from right.

In the same issue, an item on page 10 stated that PASTURE, a customized computer program that helps small farmers make grazing decisions, was available to extension agents. It should have said that they may obtain output files—rather than software—from the program's co-author, Michael A. Brown.

Banishing Brittle Bones With Boron?

Boron, an element long known for softening water, may play an important role in hardening bones, Agricultural Research Service scientists report.

A 6-month study indicates that boron, not even considered an essential nutrient for people and animals, may be a key to preventing osteoporosis, say nutritionist Forrest H. Nielsen and anatomist Curtiss D. Hunt at ARS' Grand Forks, North Dakota, Human Nutrition Research Center.

They believe the results of the study—the first to look at the nutritional effects of boron in humans—"will generate a lot of interest in the element."

In the study, 12 postmenopausal women consumed a very low boron diet (0.25 milligrams per day) for 17 weeks then were given a daily 3-mg supplement—representing the boron intake from a well-balanced diet—for 7 more weeks.

Within 8 days after the supplement was introduced, they lost 40 percent less calcium, one-third less magnesium, and slightly less phosphorus through the urine. In fact, their calcium and magnesium losses were lower than prestudy levels, when they were on their normal diets.

"These elements are important in maintaining the integrity of bone," says Nielsen, who is director of the Center.

Each day the women took the 3-mg boron supplement they retained an average of 52 mg more calcium. "That's a gram of calcium every 20 days. The body contains roughly 1,100 grams of calcium, so over a period of several years, that's a significant savings in calcium," Nielsen says.

"Boron has a remarkable effect on indicators that the body is conserving calcium or preventing bone demineralization," he says. "But we really became excited when we saw its effect on steroid hormones."

Blood levels of the most active form of estrogen—estradiol 17B—doubled to "levels found in women on estrogen replacement therapy," he says, noting that they were also 50 percent higher than prestudy levels. "And blood levels of testosterone—the precursor of estradiol—more than doubled.

"These steroid hormones are thought to be very important for maintaining bone and calcium status," says Nielsen. "In fact, estrogen replacement is currently the only proven treatment for osteoporosis."

Hunt says he suspects that "the body needs boron to synthesize estrogen, vitamin D, and other steroid hormones. And it may also protect these hormones against rapid breakdown." In his studies on chickens, for example, boron helped the animals overcome low vitamin D levels that stunted their bone growth.

Hunt believes boron is involved in adding the hydroxyl (hydrogen-oxygen) groups that steroids need to be biologically active. "But," he says, "there is no experimental evidence to support this hypothesis yet."

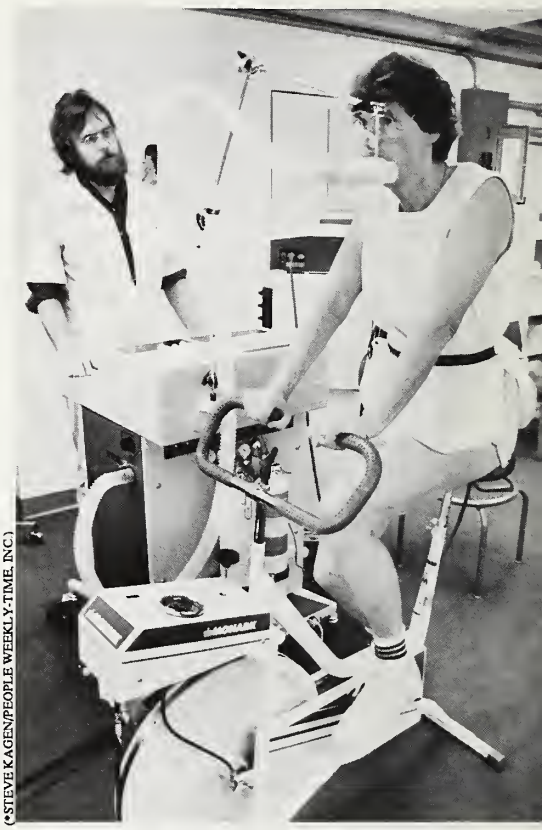
He and Nielsen will be taking a closer look at the thesis in two more human studies scheduled to begin early in 1988.

Nielsen says that their boron research began 6 years ago when they found that boron improved the growth of chickens whose diets were deficient in vitamin D.

The subtlety of boron's function in the body has probably kept it from being "discovered" until now, says Nielsen. "If you don't need it to overcome certain inadequacies, you don't know it's missing. You have to put a little stress on the hormone system before you start seeing the effects."

The element was recognized as essential for plants in the 1920's, he says, "but plant scientists still don't know how it functions."

A 6-month study with 12 women volunteers indicates that boron—not presently considered an essential nutrient for people or animals—may be a key to preventing osteoporosis.



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To monitor vital signs during the boron study, biologist Clint Hall measures heart rate, blood pressure, and oxygen consumption as Liz Payne rides an exercise bike.

Since boron isn't considered essential for people, there is no recommended intake and no boron supplement on the market. Nielsen says the supplement of sodium borate used in the study was specially prepared based on the amount of boron a person would get from a well-balanced diet containing fruits and vegetables. He says the average boron intake is about 1.5 mg—or half the experimental dose—"but average means a lot of people get less and a lot get more."

Hunt cautioned that large doses of boron can be toxic, even lethal. The lowest reported lethal dose of boric acid is about 45 grams (1.6 ounces) for an adult and only 2 grams (0.07 ounce) for an infant.

People can get ample boron—up to 4 or 5 mg per day—by eating plenty of fruit—especially apples, pears, and

(©STEVE KAGEN/PEOPLE WEEKLY-TIME, INC.)

After consuming her boron-supplemented meal, Elaine Moody (right) "cleans up her plate" to be assured of getting every crumb of the carefully measured meal.

grapes—nuts, leafy vegetables, and legumes. These foods have the highest levels of the element as well as many essential vitamins and minerals, Hunt says.

Hunt and coworkers analyzed various foods for their boron content. (See box to right.)

Nielsen points out that "Seventh Day Adventists, who are vegetarians, have a much lower occurrence of osteoporosis than Americans as a whole; but Eskimos, who eat almost no fruits or vegetables, have a very high incidence of bone demineralization."

Osteoporosis affects as many as 15 to 20 million older Americans, predominantly women, according to a 1984 conference sponsored by the National Institutes of Health. Each year, osteoporosis contributes to about 1.3 million fractures (primarily in the hip, spine, and wrist) in people 45 years old and over. This costs an estimated $3.8 billion annually.

Calcium supplement sales are at an all-time high as women try to prevent bone loss, but little evidence exists to support the claim that adequate calcium alone prevents the loss of bone. According to Mark Hegsted, professor emeritus of nutrition at Harvard University, "osteoporosis looks like a dietary problem but not a calcium problem."

Nielsen says, "We've only scratched the surface with our research. If boron is involved in adding the hydrogen-oxygen group that steroid hormones need to be biologically active, it may be important in preventing a lot of other diseases of unknown cause—including some forms of arthritis."

Nielsen and Hunt reported findings from the human study in the November 1987 issue of *The FASEB Journal*, a new publication of the Federation of American Societies of Experimental Biology.—By **Judy McBride,** ARS.

Forrest H. Nielsen and Curtiss D. Hunt are at the USDA-ARS Grand Forks Human Nutrition Research Center, P.O. Box 7166 University Station, Grand Forks, ND 58202. ♦

Boron Content in a Serving of Various Foods[1]

Apple sauce, bottled	0.279
Grape juice, bottled	.202
Apple juice, bottled	.188
Peaches, canned	.187
Broccoli, frozen	
flowers	.185
stalks	.089
Cherries, frozen	.147
Pears, canned	.122
Carrots, canned	.075
Green beans, frozen	.046
Orange juice, frozen	.041
Lettuce, iceberg	.039
Noodles	
egg	.037
spaghetti	.006
Cornflakes, fortified	.031
Bread, white enriched	.020
Ice cream, vanilla	.019
Potatoes, canned	.017
Chicken breast, ground	.005
Coffee, freeze dried	.005
Rice, Minute	.003
Milk, 2%	.002
Beef, ground round	ND[2]
Cheese, cheddar or cream	ND
Eggs, frozen	ND
Sugar, granulated	ND

[1] Milligrams boron per 100 milliliters (3 1/3 fluid ounces or 0.42 cup) or 100 grams (3 2/3 ounces, dry weight).

[2] ND - nondetectable

Source: Curtiss D. Hunt, USDA Agricultural Research Service

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PATENTS

A Better Medfly Lure

When the Mediterranean fruit fly, "the insect of the eighties," first threatened damage to the fruit-growing areas of California, it focused national attention on the need for selective control. But before entomologists could begin to solve the problems of eradication, they needed better ways to attract the elusive pests to monitoring traps.

Agricultural Research Service scientists have invented a new lure that lasts at least twice as long as the current lure, Trimedlure. In addition, it does not tend to crystallize in cool weather, a problem that has hindered use of the standard lure. The new substance, a mixture of isomeric ethyl esters, is much more stable than Trimedlure.

How do the fruit flies feel about it? They've been attracted like flies. In tests, the new attractant has performed at least as well as the standard lure and sometimes even better.

For technical information, contact Terrence P. McGovern, USDA-ARS Insect Chemical Ecology Laboratory, Room 301, Bldg. 007, BARC-West, Beltsville, MD 20705, or Roy T. Cunningham, USDA-ARS Tropical Fruit and Vegetable Research Laboratory, P.O. Box 4459, Hilo, HI 96720. *Patent Application No. 07/042,920, "Persistent Attractants for the Mediterranean Fruit Fly, the Method of Preparation and Method of Use."*

Avian Interleukin-2

Extensive medical research has centered on a family of natural substances called interleukins. These compounds, which occur naturally in response to antigens in the bloodstream, are valued for their ability to cause T-cells to proliferate, stimulating immune systems.

Interest in interleukins has spilled over from medicine to other biosciences, capturing the attention of animal scientists. Two avian interleukins have been discovered, thus adding birds to a growing list of vertebrates with their own interleukins, a list that already includes humans, cattle, and swine.

ARS poultry immunologists have submitted patents for two interleukin compounds derived from avian lymphocytes.

The lymphocytes were collected from donor chickens and grown in a medium containing a T-cell mitogenic agent. Using this method, two types of interleukin-2, each having a different molecular weight, were generated. Each of these compounds is being separately patented.

These discoveries may help guide researchers to immunity-enhancing vaccines, ensuring healthier, more disease-resistant chicks in the future.

For technical information, contact Jagdev M. Sharma, USDA-ARS, Regional Poultry Research Laboratory, 3606 East Mount Hope Road, East Lansing, MI 48823. *Patent Application Serial No. 07/054,638 and 07/054,561, "Avian Interleukin-2."*

Antibiotic for Wheat Roots

See page 4 for information on *Patent Serial No. 06/817,374, "Novel Phenazine Antibiotic From* Pseudomonas fluorescens."

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Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks Office, Washington, DC 20231. Copies of pending patents may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. ♦